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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/812,591	03/29/2004	Pooran Chandra Joshi	SLA0786	2314

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EXAMINER	
SARKAR, ASOK K	
ART UNIT	**PAPER NUMBER**
2891	

DATE MAILED: 01/18/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/812,591	JOSHI ET AL.	
	Examiner	Art Unit	
	Asok K. Sarkar	2891	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *19 December 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-32* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-32* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *29 March 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *3/29/2004*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of Species I claims 1 – 32 in the reply filed on December 19, 2005 is acknowledged.

Claim Objections

2. Claim 3 is objected to because of the following informalities: The claim has two preambles ending with a colon in lines 3 and 3 and should be corrected. Appropriate correction is required.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims 1 – 6, 9, 18 and 32 are rejected under 35 U.S.C. 102(e) as being anticipated by Belyansky, US 2004/0129673.

Regarding claim 1, Belyansky teaches a method for forming silicon dioxide (SiO2) on a silicon carbide (SiC) substrate, the method comprising:

- providing a SiC substrate;
- supplying an atmosphere including oxygen;
- performing a high - density (HD) plasma – based process; and,

- forming a SiO_2 layer overlying the SiC substrate in paragraphs 12 – 21.

Regarding claim 2, Belyansky teaches connecting a top electrode (RF coils in Fig. 1) to an inductively coupled HD plasma source in paragraph 30.

Regarding claim 3, Belyansky teaches the plasma – based process includes performing an HD plasma oxidation process in response to the HD oxidation process, creating a reactive oxygen species, breaking the Si – C bonds in the SiC substrate, to form free Si and C atoms in the SiC substrate and wherein forming a SiO_2 layer overlying the SiC substrate includes bonding the free Si atoms in the SiC substrate to the HD plasma – generated reactive oxygen species, and growing the SiO_2 layer in paragraphs 19 and 29 – 30.

Regarding claim 4, Belyansky teaches substrate temperature of 360 °C and less in paragraph 31.

Regarding claims 5 and 6, Belyansky teaches supplying an atmosphere including oxygen includes supplying O_2 with an inert gas such as Kr and Ar, where the ratio of inert gas to O_2 is in the rage between 10:1 and 200:1 in paragraph 18.

Regarding claim 9, Belyansky teaches supplying an atmosphere including oxygen includes supplying a He/O_2 atmosphere; and, wherein forming a SiO_2 layer overlying the SiC substrate includes forming a SiO_2 layer at deposition rate of about 100 Á in 10 minutes in paragraphs 19 and 29.

Regarding claim 32, Belyansky teaches a method for growing silicon dioxide (SiO_2) on a silicon carbide (SiC) substrate, the method comprising:

- providing a SiC subsfrate at a temperature of 360 degrees C, or less;

- supplying an atmosphere including oxygen;
- performing a high – density (HD) plasma oxidation process;
- in response to the HD oxidation process, creating a reactive oxygen species;
- breaking the Si – C bonds in the SiC substrate, to form free Si and C atoms in the SiC substrate; and,
- bonding the free Si atoms in the SiC substrate to the HD plasma – generated reactive oxygen species, and growing the SiO_2 layer in paragraphs 18, 19 and 30.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

7. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of

the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

8. Claims 7, 8 and 19 – 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Belyansky, US 2004/0129673.

Regarding claim 7, Belyansky teaches evacuating the plasma reaction chamber and maintaining a low reactor pressure, but fails to teach removing the CO that is formed by reaction of the oxygen and free C atoms in the chamber.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention that the during the pumping of the reactor chamber the generated CO and the other gases present inside will be evacuated during the process of plasma oxidation.

Regarding claim 8, Belyansky teaches maintaining a reactor pressure and the dilution ratios of the oxygen with the inert gases and locating the SiC between the top and bottom electrode and applying power density with respect to Fig. 1 and in paragraphs 29 – 31, but fails to teach total gas flow of ~ 50 – 200 sccm and supplying a power density of up to 10 watts per square centimeter (W/cm^2), at a frequency in the range of 13.56 to 300 megahertz (MHz), to the top electrode; and, supplying a power

density of up to 3 W/cm^2, at a frequency in the range of 40 kilohertz (KHz) to 13.56 MHz, to the bottom electrode.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention to judiciously adjust and control these parameters during the plasma oxidation process through routine experimentation and optimization to achieve optimum benefits for the deposited film (see MPEP 2144.05) without undue experimentation as taught by Belyansky in paragraph 32 and it would not yield any unexpected results.

Note that the specification contains no disclosure of either the critical nature of the claimed processes or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen methods or upon another variable recited in a claim, the Applicant must show that the chosen methods or variables are critical (*Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir., 1990)). See also *In re Aller, Lacey and Hall* (10 USPQ 233 – 237).

Regarding claims 19 and 20, Belyansky teaches that SiO_2 can be formed by HD plasma oxidation of any Si containing material in paragraph 19 but fails to teach depositing a Si layer over the SiC substrate.

However, since the oxide is formed by the reaction between the Si atom and oxygen, it would have been obvious to one with ordinary skill in the art at the time of the invention that the SiO_2 can be formed by oxidizing a thin Si layer deposited on the SiC substrate and it can be either crystalline or amorphous Si material.

Regarding claims 21 – 23, Belyansky teaches the limitations of these claims as

have been explained earlier in rejecting claims 4 – 6 and 8.

9. Claims 10 – 14, 18 and 24 – 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Belyansky, US 2004/0129673 in view of Ouellet, US 2003/0059556.

Regarding claims 10 – 14 and 18, Belyansky teaches most limitations as described earlier in rejecting claims 4 and 8, but fails to teach supplying an atmosphere including oxygen includes supplying SiH_4, N_2O, and N_2 at a ratio of 10 –25 : 100 : 50.

Ouellet teaches a PECVD method of depositing SiO_2 in an atmosphere including oxygen includes supplying SiH_4, N_2O, and N_2 for the benefit of forming an oxide film with well controlled silicon oxide stoichiometry in paragraph 9.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Belyansky and supplying an atmosphere including oxygen includes supplying SiH_4, N_2O, and N_2 for the benefit of forming an oxide film with well controlled silicon oxide stoichiometry in paragraph 9.

It would have been obvious to one with ordinary skill in the art at the time of the invention to modify Belyansky and supply the SiH_4, N_2O, and N_2 at ratios by judiciously adjusting and controlling their ratios during the plasma oxidation of the SiC substrate through routine experimentation and optimization to achieve optimum benefits by forming an oxide film with well controlled silicon oxide stoichiometry as taught by Ouellet in paragraph 9 (see MPEP 2144.05).

Note that the specification contains no disclosure of either the critical nature of the claimed processes or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen methods or upon another variable recited in

a claim, the Applicant must show that the chosen methods or variables are critical (*Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir., 1990)). See also *In re Aller, Lacey and Hall* (10 USPQ 233 – 237).

Regarding claims 24 – 30, Belyansky teaches limitations of these claims as have been described earlier in rejecting claims 10 – 14 and 19 – 23.

10. Claims 15 – 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Belyansky, US 2004/0129673 in view of Ouellet, US 2003/0059556 as applied to claim 10 above, and further in view of Chen, US 4,888,820.

Belyansky in view of Ouellet fails to teach the quality of the oxide films in terms of BTS, breakdown strength and leakage current density.

Chen teaches that these parameters are used to compare the qualities of silicon oxide films with that of the thermal oxide films as has been the standard dielectric material for silicon capacitors in column 1, lines 10 – 21.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Belyansky in view of Ouellet and control these oxide film qualities so that the quality of this film is comparable to the quality of the film formed by thermal oxidation since thermal oxide film has been the standard dielectric material for silicon capacitors as taught by Chen in column 1, lines 10 – 21 and the actual values for the plasma oxide can be controlled through routine experimentation and optimization to achieve optimum film quality in terms of dielectric property.

11. Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over Belyansky, US 2004/0129673 in view of Furukawa, US 5,135,885.

Belyansky teaches most limitations as described earlier in rejecting claims 1 – 3.

Belyansky fails to teach etching the SiO2 layer, exposing a region of the SiC substrate, and, depositing a metal in the exposed region of Sic substrate to form a metal – semiconductor contact.

Furukawa teaches etching the plasma deposited SiO2 layer on the SiC substrate, exposing a region of the SiC substrate, and, depositing a metal in the exposed region of SiC substrate to form a metal – semiconductor contact with reference to Figs. 1(d) and 1(E) in column 7, lines 35 – 45 for the benefit of making a SiC device that is useful for high temperature operation.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Belyansky and etch the plasma deposited SiO2 layer on the SiC substrate, exposing a region of the SiC substrate, and, depositing a metal in the exposed region of SiC substrate to form a metal – semiconductor contact for the benefit of making a SiC device that is useful for high temperature operation as taught by Furukawa in column 7, lines 35 – 45.

Conclusion

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Asok K. Sarkar whose telephone number is 571 272 1970. The examiner can normally be reached on Monday - Friday (8 AM- 5 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, William B. Baumeister can be reached on 571 272 1722. The fax phone

number for the organization where this application or proceeding is assigned is 571-273-8300.

13. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Asok K. Sarkar
January 13, 2006

Primary Examiner